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(54) Title of Invention: Mold Apparatus

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SPECIFICATIONS

Title of the Invention

Mold Apparatus

2. Claim

Mold apparatus that has a fixed mold, a movable mold that forms a product cavity by contacting this fixed mold, a runner that passes through the above-mentioned fixed mold for conducting molten resin inside the above-mentioned product cavity and opens into the above-mentioned product cavity at a gate part, a torpedo that is positioned inside the above-mentioned fixed mold and opens and closes the above-mentioned gate part from the side of the above-mentioned fixed mold, a resin pressure sensor that detects the pressure of molten resin flowing into the above-mentioned product cavity, and a drive mechanism that controls the position of the above-mentioned torpedo to adjust the amount of opening of the above-mentioned gate part based on the detection signal of this resin pressure sensor.

Detailed Description of the Invention

[Industrial Field of Application]

This invention pertains to a mold apparatus. More particularly, this invention pertains to a mold apparatus that molds resin.

[Prior Art]

To indicate mold apparatuses by prior art, examples are Japan Unexamined Patent No. 55-86727 and Japan Unexamined Patent No. 55-132226.

The mold apparatus indicated in the former opens and closes gate (4) opening into cavity (3) by bar (5), and controls the amount and direction of flow of molten resin packed into cavity (3).

The mold apparatus indicated in the latter opens and closes flow route (33) opening into cavities (14) and (15) by gate pin (37), and supplies and stops [illegible] into cavities (14) and (15).

[Problems that the Invention is to Solve]

However, in the mold apparatus indicated in the former, because bar (5) and its moving mechanism are positioned inside moving mold (2) and gate (4) opens into fixed mold (1), the amount of opening of gate (4) must be adjusted by passing bar (5) into cavity (3). Therefore, when gate is completely closed, bar (5) is passed into cavity (3) and product solidifying inside cavity (3) is split by bar (5). As a result, this has the problem that bar (5) cannot completely close gate (4), and after the product has solidified, superfluous parts solidified onto the gate must be cut off in a separate step.

In the mold apparatus indicated in the latter, because opening and closing flow route (33) by gate pin (37) simply causes one type of material to flow into cavities (14) and (15), this only supplies and stops this material, and it is impossible to control factors such as the amount and pressure of material made to flow into cavities (14) and (15) by adjusting the amount of opening of this flow route (33).

[Means of Solving the Problems]

The purpose of this invention is to solve the problems described above. For this purpose, this invention is designed as follows: It is a mold apparatus that has a fixed mold, a movable mold that forms a product cavity by contacting this fixed mold, a runner that passes through the above-mentioned fixed mold for conducting molten resin inside the above-mentioned product cavity and opens into the above-mentioned product cavity at a gate part, a torpedo that is positioned inside the above-mentioned fixed mold and opens and closes the above-mentioned gate part from the side of the above-mentioned fixed mold, a resin pressure sensor that detects the pressure of molten resin flowing into the above-mentioned product cavity, and a drive mechanism that controls the position of the above-mentioned torpedo for adjusting the amount of opening of the above-mentioned gate part based on the detection signal of this resin pressure sensor.

[Embodiment]

Next, embodiments of this invention are explained based on the figures. Figure 1 is a section that shows the first embodiment. In this figure, 1 is a fixed mold, and is fixed to a base (not shown) fixed to

the floor of a factory. Movable mold 2 is placed in a position opposite this fixed mold 1, and by this movable mold 2 contacting fixed mold 1, forms first product cavity 3 and second product cavity 4 on this contact surface. This first product cavity 3 and second product cavity 4 are independent of each other.

Fixed bar 5 is installed on the back of the above-mentioned fixed mold 1, and runner 6 is dug out inside this fixed bar 5 and the above-mentioned fixed mold. The end of this runner 6 on the side of fixed bar 5 is connected to a resin injector (not shown), and after passing through fixed bar 5, runner 6 branches in two inside fixed mold 1. In addition, these two branches of runner 6 proceed inside fixed mold 1 toward each of the above-mentioned first product cavity 3 and second product cavity 4, and the surface area of these routes rapidly diminishes to where they open into the above-mentioned first product cavity 3 and second product cavity 4. Moreover, the parts of runner 6 where the surface area of these routes rapidly diminishes as described above are called gates 7.

Resin pressure sensors 8 that detect resin pressure inside each of the product cavities are installed in the above-mentioned movable mold 2 at positions opposite the above-mentioned first product cavity 3 and second product cavity 4. These resin pressure sensors 8 are comprised of parts such as piezoelectric elements or strain gauges, and are installed such that they detect resin pressure in the center part between furthest end of the product cavity and the opening of gate 7. In addition, these resin pressure sensors 8 are wired to computer 9, which stores the optimum pressure inside the product cavities.

Bar-shaped torpedo 10 for adjusting the amount of opening of gates 7 is placed inside each of the two branches of the above-mentioned runner 6. The end of this bar-shaped torpedo 10 on the side of gate 7 gradually diminishes in diameter and is shaped such that it can satisfactorily close the above-mentioned gate 7. In addition, when torpedo 10 completely closes gate 7, this end of torpedo 10 is positioned on the same plane as the surface of the above-mentioned fixed mold 1 facing the product cavities. Moreover, the other end of torpedo 10 passes through the above-mentioned fixed mold 1 and is connected to piston 101. This piston 101 is inserted such that it can slide inside cylinder 11 installed inside the above-

mentioned fixed bar 5, and the position of torpedo 10 is determined by varying the falling pressure introduced into plates formed on both sides of this piston 101.

Next, the drive mechanism is described that controls the fluid pressure supplied inside the above-mentioned cylinder 11 for determining the position of this torpedo 10. Moreover, in Figure 1, only the drive mechanism that drives torpedo 10 on the side of first product cavity 3 is shown, but torpedo 10 on the side of second product cavity 4 is driven in exactly the same way, and the following explanation applies to it equally.

Inside the above-mentioned cylinder 11 is partitioned into first chamber 12 and second chamber 13 by piston 101. Tube 51 is connected to this first chamber 12 and tube 52 is connected to second chamber 13. These tubes 51 and 52 are connected to solenoid direction-switching valve 14 that has three settings. In addition, these tubes 51 and 52 are connected to or cut off from tube 53 or tube 56 by solenoid direction-switching valve 14. Tube 53 is connected to a fluid pressure apparatus (not shown), and tube 56 branches into two tubes 54 and 55. Tube 55 has installed on it, flow volume control valve 15 that can vary the area of its tube flow-route and first solenoid valve 16 that connects or cuts off this flow route, and is connected to an fluid tank apparatus (not shown) that stores the hydraulic fluid that flows through this tube. Moreover, when the above-mentioned first solenoid valve is open, hydraulic fluid inside tube 55 can only flow in the direction from solenoid direction-switching valve 14 toward the fluid tank apparatus.

The above-mentioned tube 54 engages the above-mentioned tube 55 bypassing the above-mentioned flow volume control valve 15 and first solenoid valve 16, and has second solenoid valve 17 that connects or cuts off its flow route installed midway.

The above-mentioned solenoid direction-switching valve 14, first solenoid valve 16, and second solenoid valve 17 are each connected to the above-mentioned computer 9 and driven based on control signals from this computer 9.

Moreover, the above-mentioned solenoid direction-switching valve 14 has a first setting that connects tube 51 to tube 53 and tube 52 to tube 56, a second setting that cuts off tubes 51 and 52, and a third setting that connects tube 51 to tube 56 and tube 52 to tube 53.

Next, the operation of the apparatus of this embodiment is explained.

If pressure in the product cavities is too low, the product produced has low density and is subject to deformation, and molten resin flow becomes unsatisfactory. On the other hand, if pressure is too high, molten resin seeps around the contact surface between movable mold 2 and fixed mold 1 and causes burrs. Therefore, when molten resin flows through runner 6 into product cavities 3 and 4, its pressure is detected by resin pressure sensors 8, and this detection signal is sent to computer 9. Computer 9 stores the optimum resin pressure, and after comparing the pressures sent by resin pressure sensors 8 to this optimum resin pressure, sends drive signals to the above-mentioned solenoid direction-switching valve 14 and first and second solenoid valves 16 and 17.

First, when the resin pressure inside product cavities 3 and 4 is lower than the optimum pressure, solenoid direction-switching valve 14 is switched to its first setting, first solenoid valve 16 is switched to connected, and second solenoid valve 17 is switched to cutoff. Upon this, hydraulic fluid flows through tube 53 and tube 51 into first chamber 51, and hydraulic fluid inside second chamber 52 flows out through tube 52 and tube 55 into the fluid tank apparatus. Therefore, this breaks the pressure balance between first chamber 12 and second chamber 13, and pistons 101 and torpedoes 10 move in the direction that opens gates 7 (to the right in Figure 1). In addition, molten resin flowing in runner 6 flows from gates 7 into product cavities 3 and 4, and resin pressure inside product cavities 3 and 4 increases. The movement speed of torpedoes (10) at this time is determined by flow volume control valve 15. When this flow volume control valve 15 is constricted, the movement speed of torpedoes (10) becomes slower, and when it is opened, this movement speed becomes faster. In addition, when first solenoid valve 16 is shut, torpedoes 10 stop in their current position.

Next, when the resin pressure inside product cavities 3 and 4 is greater than the optimum pressure, solenoid direction valve 14 is switched to its third setting, first solenoid valve 16 is opened, and second solenoid valve 17 is shut. Upon this, hydraulic fluid inside first chamber 12 flows out through tubes 51, 56, and 55 and into the fluid tank apparatus, and hydraulic fluid flows through tubes 53 and 51 into second chamber 13. Therefore, due to the difference in pressure between first and second chambers 12 and 13, the torpedoes are moved in the closing direction (to the left in Figure 1), the amount of molten resin flowing from runner 6 into product cavities 3 and 4 diminishes, and at the same time, resin pressure also decreases. Moreover, in this case as well, the movement speed of torpedoes (10) at this time is determined by flow volume control valve 15.

By repeating control of torpedo position as described above, resin pressure in product cavities 3 and 4 can be kept at the optimum pressure.

Following this, when packing molten resin into product cavities 3 and 4 is completed, solenoid direction-switching valve 14 is switched to its third setting, first solenoid valve 16 is shut, and second solenoid valve 17 is opened. Upon this, hydraulic fluid in first chamber 12 flows out through tubes 51, 56, and 54 into the fluid tank apparatus, bypassing flow volume control valve 15. As a result, torpedoes 10 are moved to the left in Figure 1 as described above and can close gates 7.

In addition, after a set time has elapsed, when resin inside product cavities 3 and 4 has completely solidified, movable mold 2 is withdrawn from fixed mold 1, the product is removed, and resin molding is completed.

Figure 2 shows the second embodiment of this invention. In this example, resin temperature sensor 20, fixed mold temperature sensor 21, and movable mold temperature sensor 22 are further installed in the apparatus of the first embodiment. Resin temperature sensor 20 is installed in fixed mold 1 facing runner 6, and detects the temperature of molten resin in runner 6. Fixed mold temperature sensor 21 is installed inside fixed mold 1 and movable mold temperature sensor 22 is installed movable mold 2,

and detect the temperature of each of these molds. Moreover, sensors 20, 21, and 22 are each connected to computer 9.

When an apparatus such as this second embodiment is used, resin pressure inside the product cavities can be kept adequately at the optimum pressure even when mold temperatures and resin temperature vary.

Moreover, when the volumes of first and second product cavities 3 and 4 differ especially, in standard molds, this often causes burrs on the smaller product and insufficient resin in the bigger product. Therefore, by opening the gate for the bigger product first and injecting resin, then opening the gate for the smaller product after a delay, both products can be obtained with satisfactory quality.

In addition, in the case of multiple-gate products, this causes weld lines where resin flowing from different gates meets, but often it is desirable that these places be distant from certain locations on the product (such as locations that are easily visible). In this case, weld lines can be positioned by determining the optimum timing for opening each gate.

In addition, in the embodiments described above, torpedoes 10 were operated by fluid pressure, but these also can be operated by a means such as a motive source combining a motor and a gear mechanism.

In addition, in the embodiments described above, gate opening was controlled such that the resin pressure matches the optimum pressure for product quality, but the control method of opening gates after the resin pressure reaches a set pressure also is possible. In this case, a simple control design may be used without using computer 9.

[Effects of the Invention]

As explained above, when the mold apparatus of this invention is used, because the gate parts of a runner installed in the fixed mold are opened and closed by torpedoes, gate parts can be opened and closed with absolutely no deformation of the product. In addition, because these gate parts are opened

and closed by adjusting the amount of opening according to the resin pressure inside the product cavities, resin pressure in always kept at the optimum pressure and problems such as insufficient flow of molten resin or burrs do not occur.

4. Brief Explanation of the Figures

Figure 1 is a section that shows the first embodiment of this invention. Figure 2 is a section that shows the second embodiment of this invention.

1 ... fixed mold, 2 ... movable mold, 3 ... first product cavity, 4 ... second product cavity, 6 ... runner, 7 ... gate part, 8 ... resin pressure sensor, 10 ... torpedo, 14 ... solenoid direction-switching valve, 15 ... flow volume control valve, 16 ... first solenoid valve, 17 ... second solenoid valve

Representative: Takashi Okabe, Patent Attorney

Figure 1

Key: 1 ... fixed mold, 2 ... movable mold, 3 ... first product cavity, 4 ... second product cavity, 6 ... runner, 7 ... gate part, 8 ... resin pressure sensor, 10 ... torpedo, 14 ... solenoid direction-switching valve, 15 ... flow volume control valve, 16 ... first solenoid valve, 17 ... second solenoid valve